

***Coccinia intermedia* – a new Cucurbitaceae species from West Africa**

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Abstract

Nuclear and plastid sequences from two individuals of a suspected new species of *Coccinia* from West Africa were added to an available molecular phylogeny for the remaining 27 species of the genus. Phylogenetic analyses of these data indicate the new species' monophyletic status and closest relatives. Based on four fertile collections, we here describe and illustrate *Coccinia intermedia* Holstein. We also provide a key to the *Coccinia* species of West Africa and map their distributions.

Keywords

Benin, Ivory Coast, Ghana, leaky dioecy, molecular phylogenetics, species monophyly, Togo

Introduction

The genus *Coccinia* Wight et Arn. so far consisted of 27 species distributed mainly in Sub-Saharan Africa, with centers of diversity in East Africa and southern Africa (Holstein, ongoing monograph). Only four species were known from West Africa, including *C. longicarpa* Jongkind, *C. keayana* R. Fern., and *C. barteri* (Hook. f.) Keay, which apparently evolved during Pliocene-Pleistocene climatic oscillations (Holstein and Renner 2011). The fourth species, *C. grandis* (L.) Voigt, is much more widespread, occurring not only in Africa but also in South and South East Asia, and being naturalized on several Pacific islands, Australia, and in the Neotropics. During a study of

the evolution and biogeography of the genus (Holstein and Renner 2011), we came across a male specimen from the northeastern Ivory Coast that in its plastid sequences differed sufficiently from all other sequenced material for us to suspect it might represent a new species. We therefore provisionally labeled it *Coccinia* sp. nov. We have since found three more specimens of the new species, all of them with fruits, and two with flowers, and based on their morphology as well as additional nuclear and plastid sequences, we here describe the new species *C. intermedia*.

Methods

We produced new sequences of the plastid *rpl20–rps12* intergenic spacer (JN653687), *trnS^{GCU}–trnG^{UCC}* intergenic spacer (JN653686) and the nuclear *LEAFY*-like second intron (JN653688) from the female specimen A. Akoègninou et al. 2625 (WAG0278370) of the new species, following standard procedures (Holstein and Renner 2011). We added the new sequences, named “*C. intermedia* 2”, to our published matrices and carried out maximum likelihood tree searches, using the approaches described in Holstein and Renner (2011).

Results

Phylogenetic placement

The two *Coccinia intermedia* accessions in the plastid tree form a clade (Fig. 1) within the *barteri* clade. In the nuclear *LEAFY* phylogeny, *C. intermedia* groups with *C. barteri*, *C. heterophylla* (Hook.f.) Holstein, *C. keayana*, *C. longicarpa*, *C. mildbraedii* Gilg, and *C. racemiflora* Keraudren (Fig. 2), albeit without bootstrap support.

Morphological description

***Coccinia intermedia* sp. nov.**

urn:lsid:ipni.org:names:77115897-1

http://species-id.net/wiki/Coccinia_intermedia

A *Coccinia longicarpa* differt calycis dentibus angustis, corolla campanulata et fructu elliptico ad oblongo. A *C. keayana* et *C. grandis* differt calycis dentibus ad corollam adpressis vel apicem versus leviter recurvatis et lamina foliorum subtus glandibus fuscis provisa. A *C. barteri* differt floribus femineis 1–3 fasciculatis non racemosis, corolla campanulata.

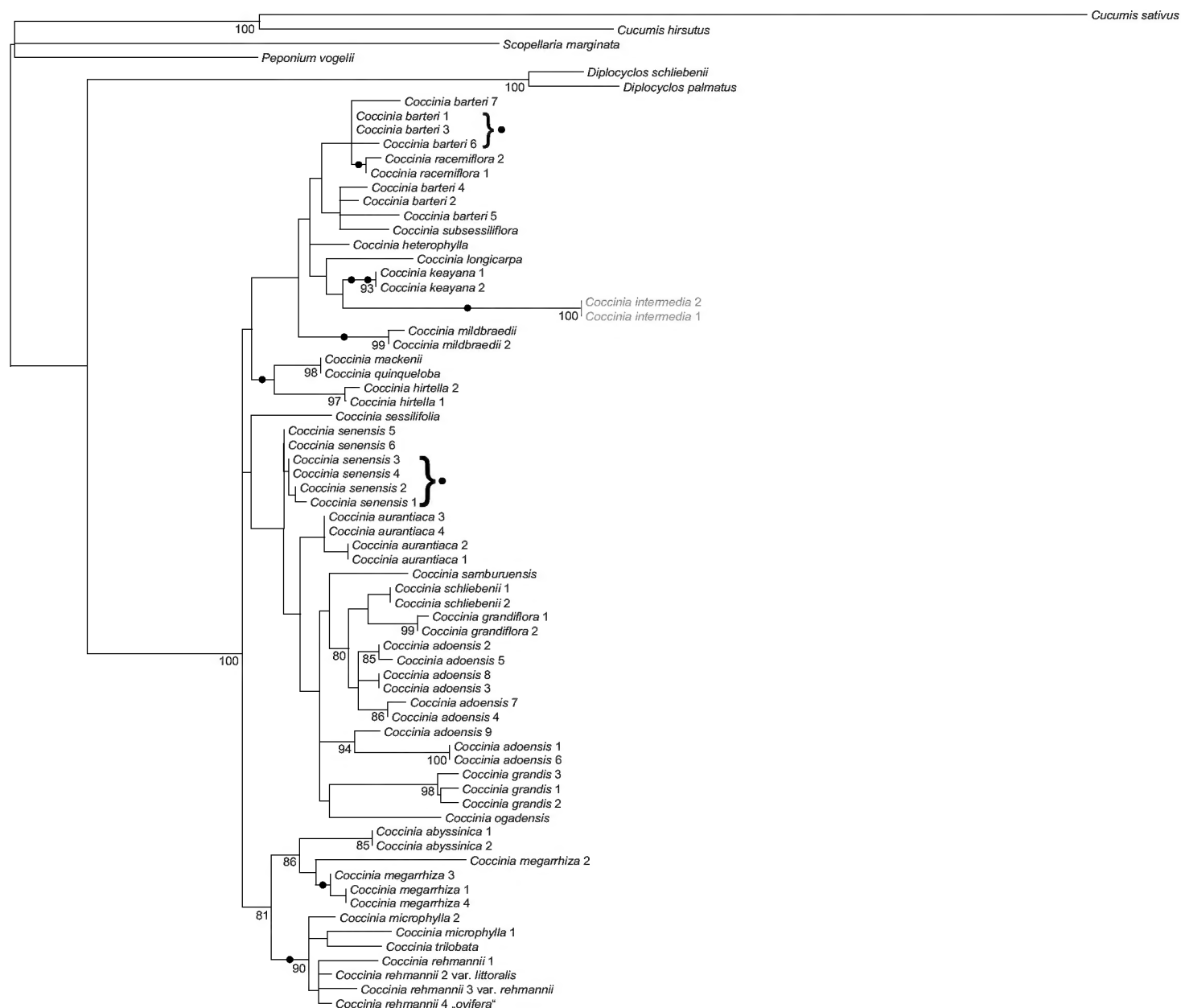


Figure 1. Maximum likelihood phylogeny for *Coccinia* based on plastid DNA sequences analyzed under GTR+ Γ model of substitution. The tree is based on 4,551 nucleotides (140 parsimony-informative sites) from the *trnS*^{GCU}–*trnG*^{UCC} intergenic spacer (IS), the *rpl20*–*rps12* IS, the *ndhF*–*rpl32* IS, *trnL*^{UAA} intron, *trnL*^{UAA}–*trnF*^{GAA} IS, and the *matK* gene (expanded matrix from Holstein and Renner 2011). Numbers below branches represent bootstrap support $\geq 80\%$ from 1000 replicates. Dots on branches and behind brackets refer to uniquely shared insertions or deletions. Species names follow Holstein and Renner (2011) except for the new species *C. intermedia* 1, earlier called *Coccinia* sp. nov.

Type. BENIN. Atakora: Natitingou, Kouaténa (Perma), 10°12.00'N; 1°30.18'E, river bed, female, fl, fr, 3 Oct 2000, A.Akoègninou et al. 3625 (Holotype: WAG0278370!; isotype: WAG0278369!).

Description. Perennial, diclinous climber. Shoot length unknown, but likely several meters. Shoots lignify with whitish bark and up to 1 cm diam. Fresh shoots green, glabrous, older shoots with clear to white pustules. Petioles 2.8–10.8 cm, glabrous, when older with clear to white pustules (Fig. 3a). Leaves 6–15 × 7–18 cm, shallowly to profoundly 5-lobate, more or less auriculate (Fig. 4). Upper lamina glabrous with clear to whitish pustules. Lower lamina paler than upper lamina, glabrous, often with small dark glands near the leaf base (Fig. 3a). Tendrils simple or

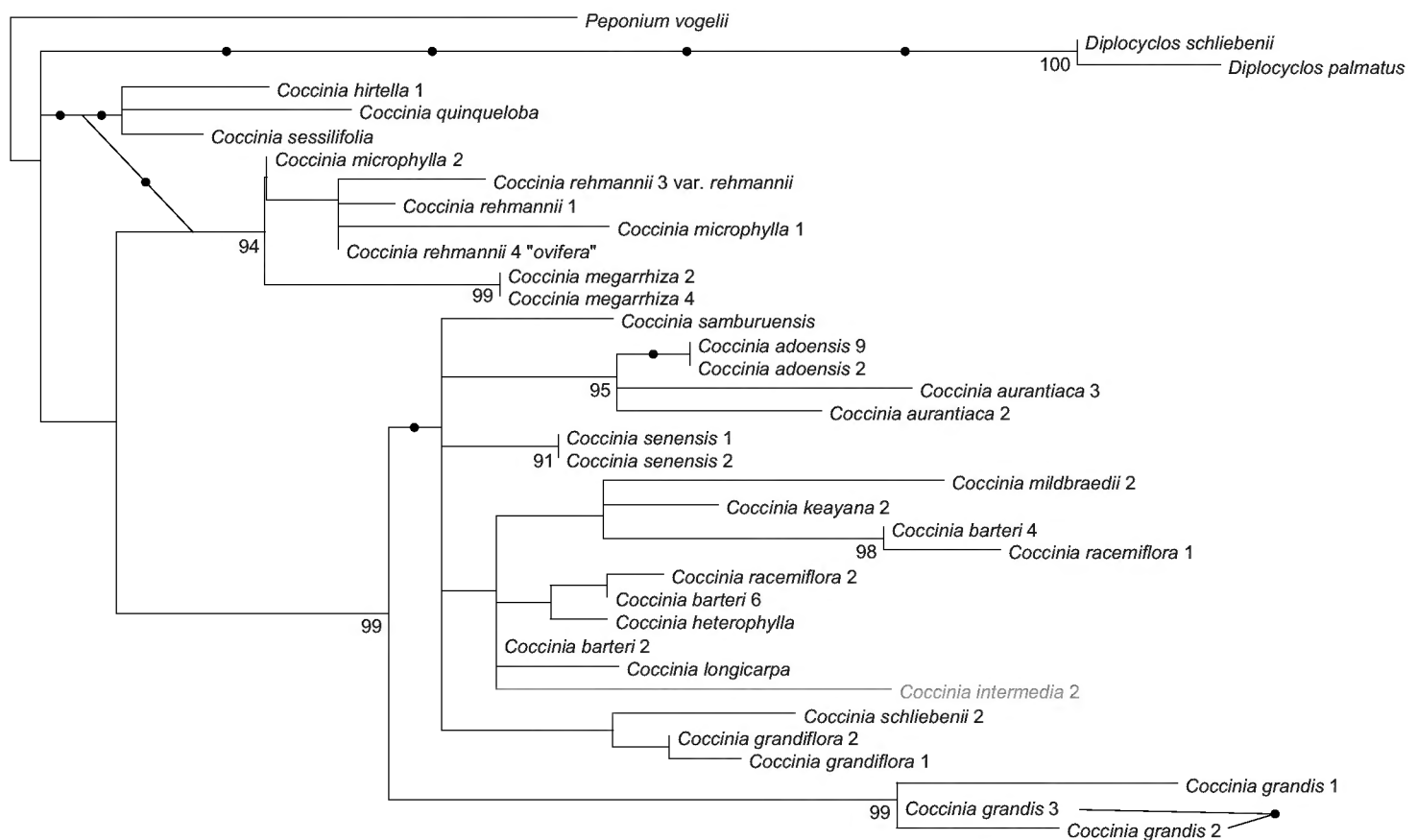


Figure 2. Maximum likelihood phylogeny for *Coccinia* based on nuclear DNA sequences from the *LEAFY*-like 2nd intron analyzed under the GTR+Γ model of substitution. The tree is based on 505 nucleotides (56 parsimony-informative sites). Numbers below branches represent bootstrap support ≥ 80% from 100 replicates. Dots on branches and behind brackets refer to uniquely shared insertions or deletions. Species names follow Holstein and Renner (2011) except for the new species *C. intermedia*.

bifid. Probracts up to 2.5 mm long, glabrous, apex rounded (Fig. 3a). Male flowers in few-flowered racemes (Fig. 5), likely sometimes accompanied by a single flower. Common peduncle up to 1 cm, pedicels in racemose flowers 2–4 mm, glabrous. Bracts up to 1.5 mm long, round to obovoid. Receptacle pale green, glabrous. Calyx teeth 1.5 mm long, lineal to narrow triangulate, erect with slightly recurved tips (Figs. 3–5). Corolla campanulate, 1.6 cm long, pale reddish-yellow to yellow, lobes 0.7 cm long (Fig. 5). Anthers sinuate, in a globose head (Fig. 3c). Pollen unknown. Female flowers 1–3 clustered (strongly reduced raceme; Fig. 4). Pedicels 0.6–1.2 cm, glabrous. Perianth like in males. Ovary fusiform, glabrous. Stigma and staminodes unknown. Fruit 4.5 × 2.5 cm, elliptical to oblong, smooth. Unripe green with pale green longitudinal mottling. Ripe orange?, more likely becoming red via orange ripening stage. Fruit with waxy cover. Size of mature seeds unknown (≥ 5.5 × 3.5 × 1.3 mm), symmetrical (to slightly asymmetrical), face flat (Fig. 3b).

Distribution. (Fig. 6). NE Ivory Coast, SE Ghana (likely also in the north), S Togo (likely also in the north), NW Benin. Based on the current collections, *Coccinia intermedia* is likely to occur in the Dahomey Gap region and the *Isobertlinia* woodlands of West Africa.

Ecology. Wooded grasslands (semi-humid savanna), woodlands, dry forests, and along rivers. Flowering specimens have been collected during May, August, and October, which in each site was during or shortly after the rainy season.

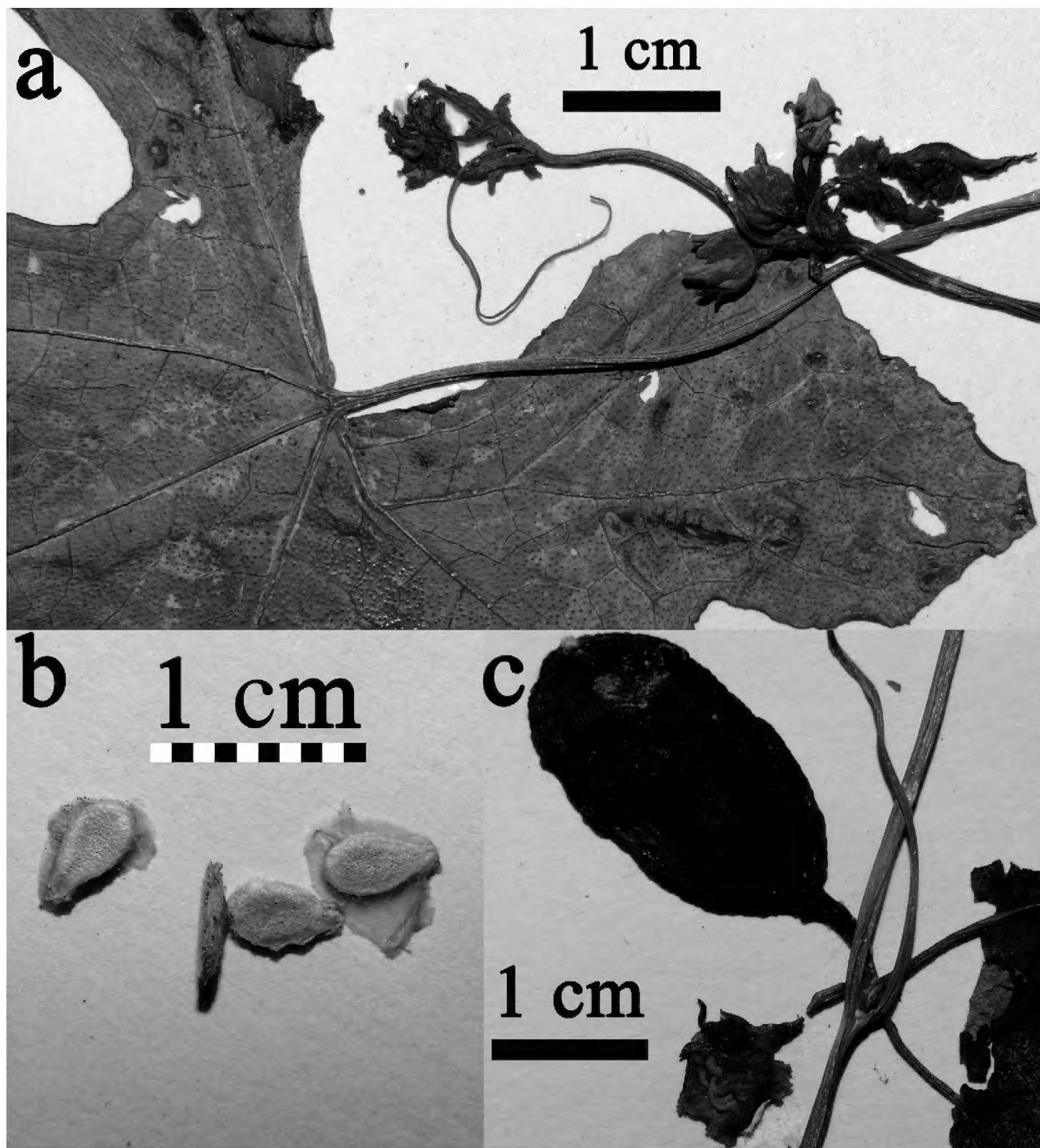


Figure 3. **a** *Coccinia intermedia* leaf basis and node with flowers **b** seeds from late, but immature fruit **c** node with young fruit and male flower bud with sinuate anthers; all from J.B.Hall & J.M.Lock GC46016 (K).

Etymology. The epithet refers to the species' status as the only *Coccinia* from West Africa that occurs in habitats intermediate between semi-arid and humid conditions. Morphologically, *C. intermedia* combines characters also found in the other four West African species although not in this combination.

List of specimens examined. Benin: Atakora, Natitingou, Kouaténa (Perma), 10°12.00'N; 1°30.18'E, river bed, female, fl, fr, 3 Oct 2000, A.Akoègninou et al. 3625 (WAG 2 sheets). Ghana: Shai Hills Game Reserve, monoecious, fl, fr, 25 May 1976, J.B.Hall & J.M.Lock GC 46016 (K 4 sheets, MO). Ivory Coast: Bouna, male, fl, 10 Aug 1967, C.Geerling & J.Bokdam 662 (MO, WAG). Togo: between Lomé and Aného, female, fr, 25 Jun 1994, L.Aké Assi 18982 (MO).



Figure 4. Habitus of *Coccinia intermedia* as reconstructed from J.B.Hall & J.M.Lock GC46016 (K).

Key to West African *Coccinia* species

- 1 Plant glabrous. Leaves with few large pale glands between main nerves of lower lamina. Nerves on lower lamina with or without white pustules. Leaf margin dentate, in mature plants often red to brown (black when dry). Tendrils always simple. Male and female flowers 1 solitary (rarely male flowers clustered or in short-peduncled racemes). Calyx teeth spreading to reflexed, tips red to brown. Corolla campanulate, white or buff. Fruit ovoid. Plant of semi-arid habitats..... ***C. grandis***
- 1' Plant glabrous or with hairs, especially on adaxial petiole. Leaves with small blackish glands (often many) centered towards the leaf base or without glands on lower lamina. Tendrils simple or bifid. Male and female flowers in racemes or solitary. Corolla in yellowish tones, never white..... **2**
- 2 Plant glabrous. Leaves with small blackish glands centered towards the leaf base (Fig. 3). Nerves on lower lamina with or without white pustules. Leaf margin at maturity with colored teeth (color in living plants unknown, black when dry). Tendrils simple or bifid. Male flowers (Fig. 5) bracteate, in few-flowered racemes, female flowers 1–3 solitary/clustered (Fig. 3 and 4). Calyx teeth erect with recurved tips (Figs 3–5). Corolla campanulate. Fruit ovoid to short cylindrical. Plant of wooded grasslands (tree savanna), woodlands, or dry forests. ***C. intermedia***
- 2' Plant glabrous or with hairs, esp. on adaxial petiole. Leaves with small blackish glands centered towards the leaf base or without glands. Nerves on lower

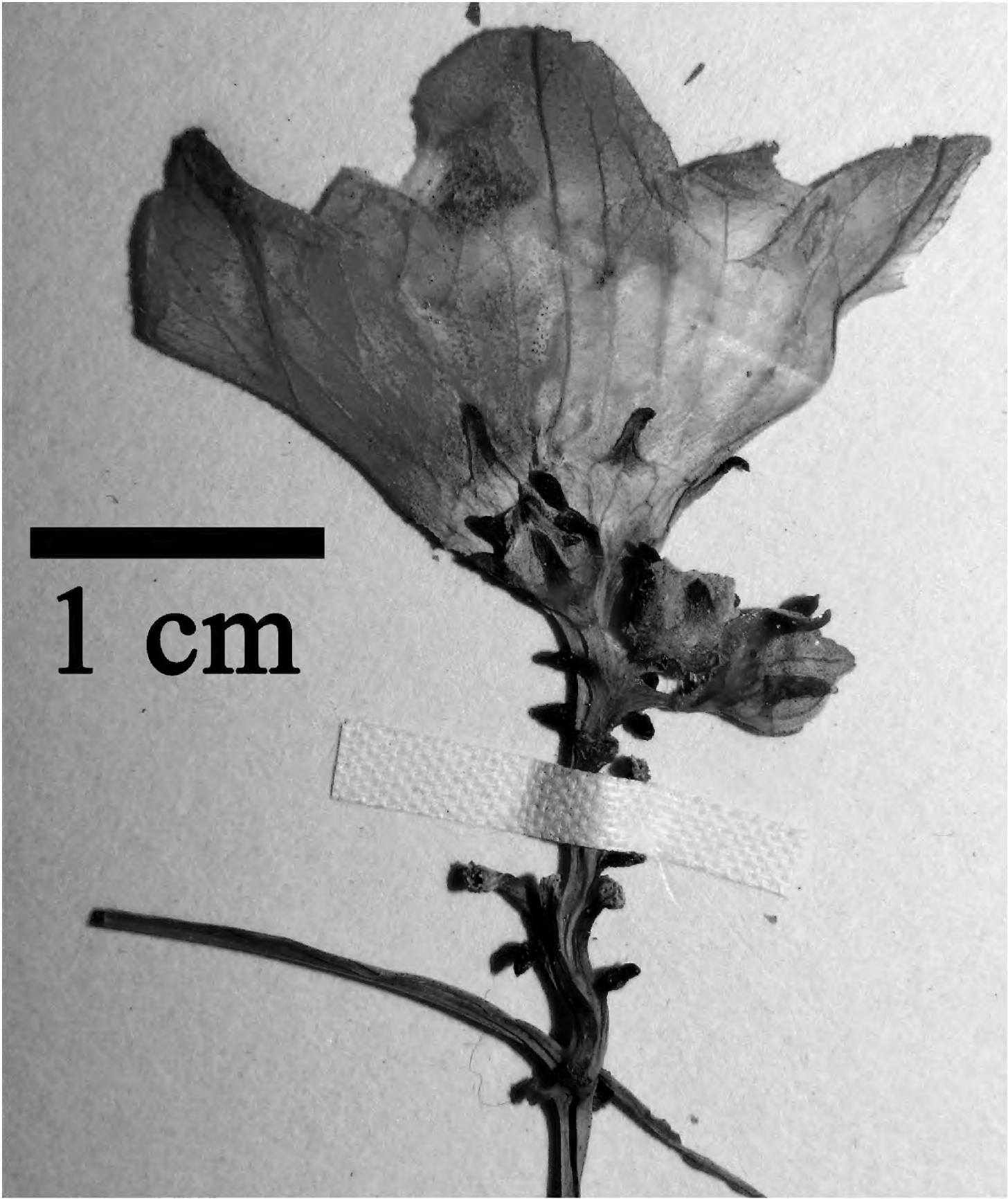


Figure 5. Male inflorescence of *Coccinia intermedia* from C.Geerling & J.Bokdam 662 (WAG).

- leaf lamina without white pustules. Tendrils simple or bifid. Male flowers in few to many-flowered racemes, rarely accompanied by a solitary flower. Female flowers in few- to many-flowered racemes or solitary. Flowers bracteate or ebracteate. Corolla urn-, cup- to funnel-shaped. Plant of humid climates (rainforests, gallery forests, etc.) **3**
- 3 Leaf margin with pale (when dry blackening) glandular teeth. Tendrils simple. Flowers without bracts, calyx teeth erect, > 1.5 mm at base. Fruits long cylindrical. *C. longicarpa*

- 3' Leaf margin without conspicuously colored teeth. Tendrils simple or bifid. Flowers with or without bracts. Calyx teeth erect, spreading, or reflexed, but narrow (< 1.2 mm at base). Fruits ovoid.4
- 4 Tendrils simple. Male flowers in lax racemes, female flowers solitary or in few-flowered racemes. Flowers without bracts. Calyx teeth in buds spreading, later reflexed. *C. keayana*
- 4' Tendrils simple or bifid. Male flowers in dense few- to many-flowered racemes, with or without bracts. Female flowers in racemes, rarely solitary. Flowers with or without bracts. Calyx teeth variable. *C. barteri*

Discussion

Coccinia intermedia is morphologically similar to the other West African species. From *C. grandis*, it differs most readily in the glands on the lower lamina and in its calyx teeth (erect with recurved tips in *C. intermedia* and spreading to reflexed in *C. grandis*). From *C. longicarpa*, it differs in its ovoid fruits (instead of long cylindrical fruits in *C. longicarpa*). Additionally, *C. longicarpa* has ebracteate racemes and much broader (> 1.5 mm at the base) erect calyx teeth, and an urn-shaped corolla. From *C. keayana*, it differs in having bracteate male flowers in denser racemes, a campanulate corolla and calyx teeth that are adpressed to the corolla with recurved tips, instead of spreading (in buds) to reflexed calyx teeth. Secure distinction of *C. intermedia* from *C. barteri* requires fertile material with flowers (see the key above).

Ecologically, the new species is a member of White's (1983) Sudanian center of endemism and his Guinea-Congolia/Sudania regional transition zone (Fig. 6). The only species with a similar habitat as *C. intermedia* is *C. adoensis*, the most western known occurrence of which is Adamawa State (eastern Nigeria). Whether the species co-occur is not known. They could be distinguished by fruit shape (not beaked in *C. intermedia*, beaked in *C. adoensis*, although this character can vary in the latter). Additionally, *C. adoensis* has inflorescence peduncles that are longer than 1 cm (in its male racemes) and petioles that are often hairy.

Two DNA characters, namely base pairs 310 and 323 in the *trnS*^{GCU}–*trnG*^{UCC} intergenic spacer region, suggest the placement of *C. intermedia* as sister to a clade that we have earlier referred to as the *Coccinia barteri* clade (Holstein and Renner 2011). If this placement is correct, then the *Coccinia* species occurring in the rain or mist forests of West and Central African are monophyletic and probably evolved *in situ*. One of the four collections, J.B.Hall & J.M.Lock GC 46016, bears male and female flowers/fruits on the same node (Fig. 3c). The male flowers are buds, and it is not clear, whether they are fertile. Kumar and Vishveshwaraiah (1952) report a “gynodioecious form” of *C. grandis* in which the male flowers of the hermaphrodite (monoecious) plants are sterile. An occasional occurrence of bisexual plants in otherwise dioecious species, sometimes called “leaky dioecy” (Baker and Cox 1984), has also been observed in other Cucurbitaceae (Schaefer and Renner 2010).

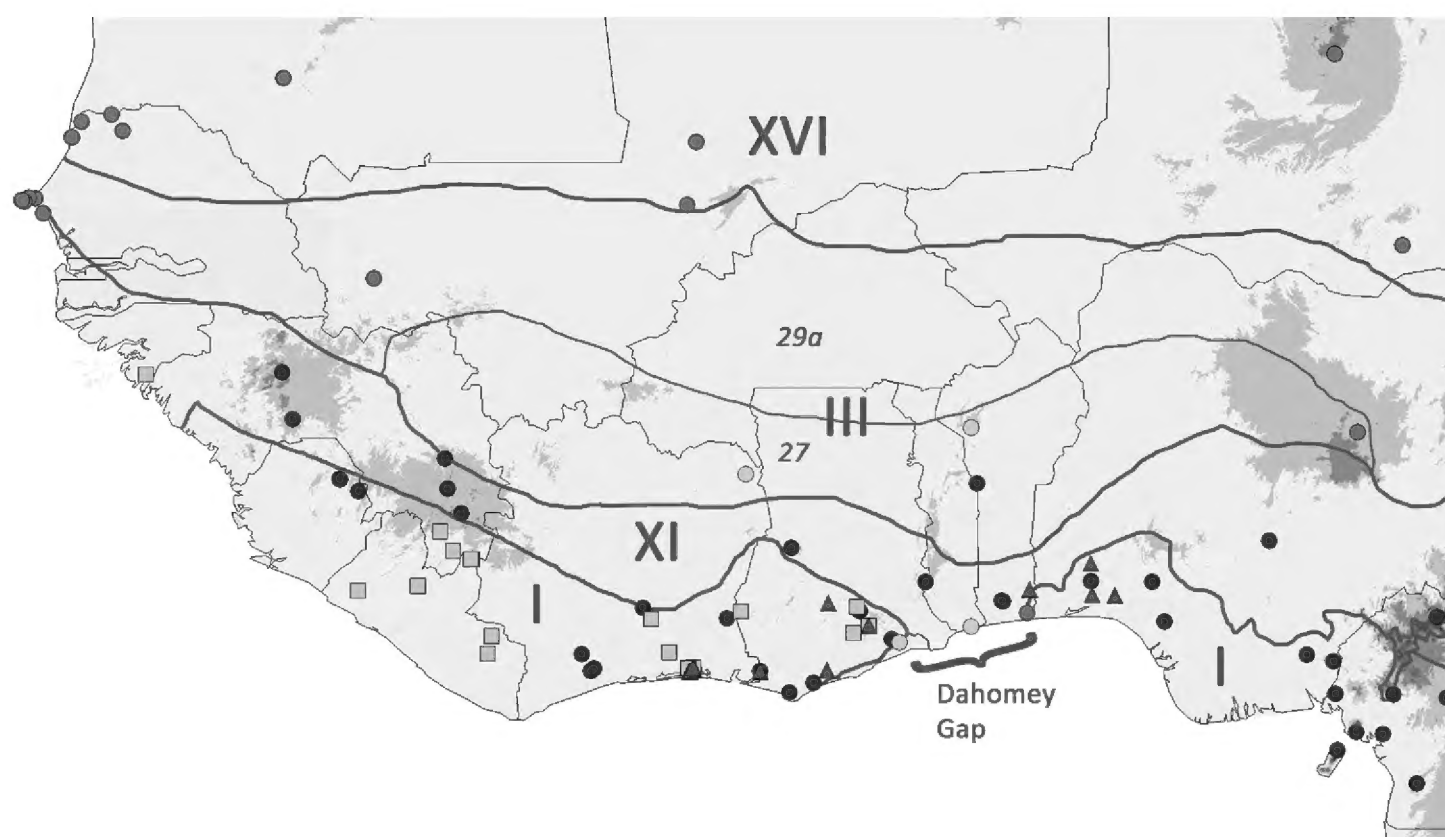


Figure 6. Map of West African *Coccinia* species. Pale yellow circles = *C. intermedia*, cyan circles = *C. grandis*, dark blue circles = *C. barteri*, pale blue squares = *C. keayana*, bright blue triangles = *C. longicarpa*. Thick dark grey lines are phytochoria drawn after White (1983), I = Guineo-Congolian regional center of endemism, III = Sudanian regional center of endemism, XI = Guinea-Congolia/Sudania transition zone, XVI = Sahel regional transition zone. Thin dark grey lines (after White (1983)) differentiate between White's vegetation types of zone III: 27 = Sudanian woodland with abundant *Isoperlinia*; 29a = undifferentiated Sudanian woodland. Location of *C. intermedia* in Ivory Coast estimated (only the department is given on the herbarium sheet).

However, true monoecy in *C. intermedia* would be surprising as none of ca. 1,500 specimens of other *Coccinia* species studied is bisexual (Holstein, ongoing monograph).

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